Lake Stewardship Program

Volunteer Lake Monitor 2004 Sampling Manual

King County
Department of
Natural Resources and Parks

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Volunteer Lake Monitor
2004 Sampling Manual

King County
Department of Natural Resources and Parks
Water and Land Resources Division
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Volunteer Lake Monitors, Hazel Wolf Wetlands Preserve

Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it's the only thing that ever has.

– Margaret Mead (1901-1978)

Cover Photo: Langlois Lake

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Lake Margaret

A lake is the landscape's most beautiful and expressive feature. It is earth's eye; looking into which the beholder measures the depth of his own nature. The fluviatile trees next the shore are the slender eyelashes which fringe it, and the wooded hills and cliffs around are its overhanging brows.

— Henry David Thoreau (1817–1862)

1. Introduction

As King County residents, we want clean lakes so we can enjoy the recreational opportunities and the natural beauty they offer. We also want to ensure that our lakes provide a healthy environment for fish, frogs, waterfowl, and other wildlife.

Our everyday actions can profoundly affect the balance of these freshwater systems, degrading the very qualities that attracted us to them in the first place. For example, nutrients in fertilizers, detergents, failing septic systems, eroding soil, and animal waste can cause algae and aquatic plants to grow and multiply rapidly. Too many plants and algae, in turn, can reduce water clarity and clog our lakes, interfering with recreational uses and the quality of wildlife habitat.

By regularly monitoring our lakes, we can evaluate how our actions affect water quality. This information helps us to be better stewards of our lakes and watersheds. King County's Lake Stewardship Program provides opportunities to learn how lakes function and how to protect water quality. The program offers technical assistance to lakeside residents, publishes a quarterly newsletter, provides lake-related workshops, and supports a network of volunteer lake monitors. It also advises groups on grant procurement and occasionally makes lake-related presentations to schools and youth groups.

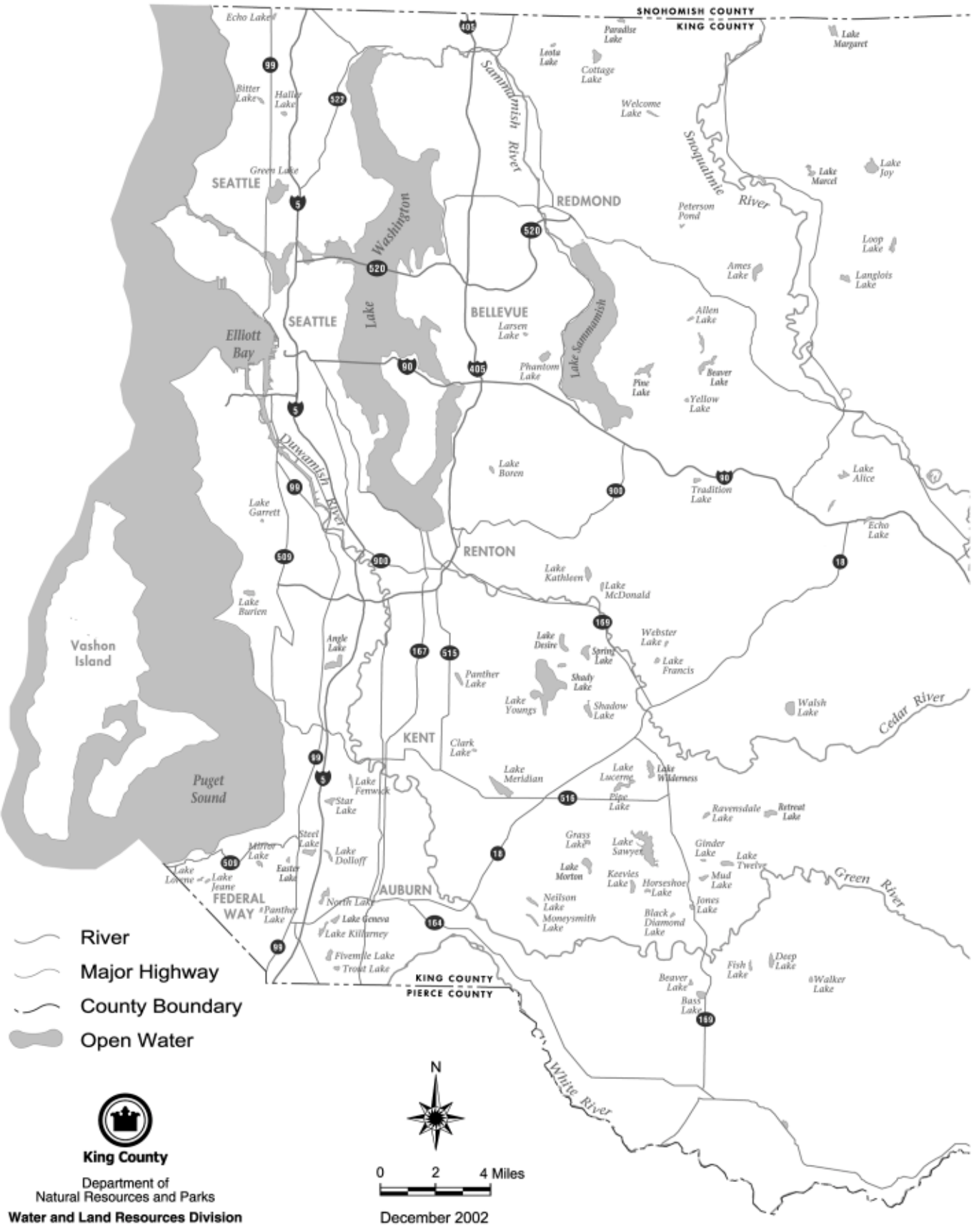
Lakeside residents may choose to volunteer their time as Level I, Level II, or back-up monitors on their lake. Level I volunteers collect information on lake level and precipitation every day, as well as Secchi depth and lake temperature on a weekly basis. Level I volunteers participate in these activities year round.

Level II volunteers collect water samples for laboratory analysis of phosphorus, nitrogen, and chlorophyll *a* and phytoplankton every other week from late April through October. They also measure physical parameters such as temperature and Secchi depth.

Back-up monitors serve an equally important role by filling in for Level I or Level II monitors when they are temporarily unavailable to collect data.

This manual provides a standard set of methods for Volunteer Lake Monitors. By following manual guidelines, volunteers will collect consistent, reliable, and representative lake data that can be used to evaluate both seasonal and long-term trends in lake water quality and lake level.

Lake Locations for Western King County



I believe a leaf of grass is no less than the journey-work of the stars.

— Walt Whitman (1819-1892)

2. Purpose of Data Collection

Lake water quality is affected by both the quantity and quality of the water flowing into it. Human activity and associated land use practices in the watershed play a large role in determining a lake's overall water quality.

The Lake Stewardship Program depends on the data collected by volunteers to:

- develop historical data records for individual lakes;
- evaluate trends in lake level and water quality over time;
- measure how water quality varies with water depth;
- detect lake problems and assist residents in solving them;
- educate citizens; and
- encourage community stewardship of the region's lakes.

With your participation as a volunteer monitor, we can build a program that enables us to evaluate and track the health of your lake and other lakes in the region.

Spring Lake

Human subtlety will never devise an invention more beautiful, more simple or more direct than does Nature, because in her inventions, nothing is lacking and nothing is superfluous.

-Leonardo da Vinci, (1452-1519)

3. Getting Started

Safety Rules for All Monitors

Safety should be the primary consideration for all volunteer monitors. Everyone needs to take personal responsibility for safety, especially during bad weather (thunderstorms and windy or rainy conditions). Additionally, docks and boats can have slippery surfaces and small boats, like canoes, can be unstable.

Remember to follow these common sense rules.

- Wear a life jacket when sampling from a boat.
- Know your local boating requirements and obey any specific restrictions applicable to your lake.
- Know how to operate the boat you are using, especially if it is not your own.
- Take a free boating safety course. Call 800-336-BOAT for more information.
- Obey all laws and practice safe boating.
- Use good judgment.

Do not go out on the lake and collect data if you think it is unsafe. No data is worth the risk of an accident.

Level I & II Monitoring Needs

The time commitment varies between Level I and Level II volunteer monitoring programs. Requirements of each monitoring program are outlined below. Many volunteers choose to participate in both Level I and Level II programs, though it is not required.

Level I: We provide the necessary monitoring equipment. You will need to provide the following.

- Easy daily access to the lake you wish to monitor. (Living on the lake you monitor is ideal.)
- Access to a boat and a place to launch it.
- A life jacket.
- A dock or fixed post for a lake level gauge.
- Approximately five minutes each day and about 30 minutes once a week.
- A pencil* and a hard surface to write on (e.g., a clipboard or notebook).

For Level II: We provide the necessary monitoring equipment. You will need to provide the following.

- Access to a boat and place to launch it.
- A life jacket.
- A secure place to store monitoring equipment.
- Approximately one hour every other Sunday or Monday between late April and October.
- A pencil* and a hard surface to write on (e.g., a clipboard or notebook).

* The datasheets provided are made of Rite-in-the-Rain paper and pens do not work well on that surface. Please use a pencil.

Level I Tasks: Year-round

Daily*

- Measure precipitation
- Measure lake level
- Note any unusual conditions

Weekly* (on lake)

- Measure lake temperature
- Measure Secchi depth
- Make algae observations and note unusual conditions

Monthly

- Mail datasheets to King County

**Same time each day.*

Level II Tasks: April - October

Every other Sunday or Monday during the sampling season volunteers should anchor their boat at the sampling station (see p. 11) and perform these tasks.

- Use the Van Dorn sampler to fill the bottles provided with water from the lake. Collect the water from the depth specified on the label on the bottle.
- Measure the Secchi depth.
- Measure the temperature of the water at one meter depth.
- Note observations and any unusual conditions on the datasheets.
- Place the completed datasheets and samples in a cooler on the porch for pickup.

NOTE: The Lake Stewardship Program can accommodate varied levels of participation other than the two outlined above. Please discuss alternative options with a Lake Stewardship Program staff person.

Allen Lake

I hear lake water lapping with low sounds by the shore;
While I stand on the roadway, or on the pavements gray,
I hear it in the deep heart's core.

— William Butler Yeats (1865–1939)

4. Sampling Location

Both Level I and Level II Volunteer Lake Monitors will need to locate the deepest part of their lake in order to set a sampling site. You will return to this spot each time to measure Secchi depth and/or gather water samples. A depth contour map for your lake is provided on page 13. This map identifies the deepest portion of your lake and will help you to establish the permanent sampling location. Follow the steps below to establish bearing lines that you can use to return to the same location each time.

1. Position your boat in the sampling location shown on your lake map (p. 13).

2. Before establishing your first bearing line, verify that you are close to the lake's deepest spot by measuring the length of line it takes to anchor your boat in this location. The depth should correspond closely to the maximum depth shown on your lake map.

3. If you find yourself at a depth significantly less than the depth shown for your sampling location, try repositioning your boat until you have located the deepest area. Let a Lake Stewardship Program staff person know if it is significantly different from what is shown on the map. Program staff can also come to your lake to get Global Positioning System (GPS) coordinates for your location for our records.

Record Sample Site Coordinates

Latitude:

N_ _ ° _ _ . _ _ ’

Longitude:

W_ _ _ ° _ _ . _ _ ’

1st Bearing Line:

_____

_____

_____

2nd Bearing Line:

_____

_____

_____

Water Depth in Meters at Deepest Point:

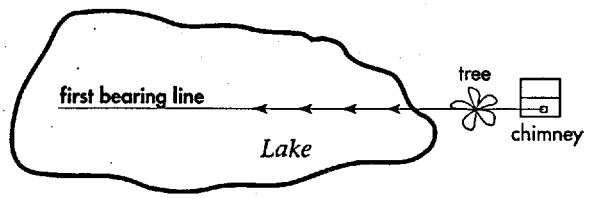
_____

_____

_____

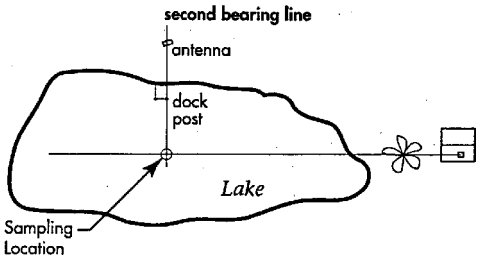
4. If you have a hand-held GPS device, use this to mark your position. If you do not, you will need to establish visual markers of your site, as follows.

5. Establish the first bearing line by identifying two fixed objects on the shore (houses, chimneys, docks, trees, fence posts) to align with one another — one in the foreground and one in the background.



6. Once you have identified two objects, you may need to alter your position slightly on the lake to get them to line up. The line that is formed between you and the shoreline objects is your first bearing line.

7. To establish your second bearing line, you will need to examine the shoreline area that is as close as possible to a right angle (90 degrees) from your first bearing line. Again, find two objects that line up with one another.



8. The intersection of your two bearing points should coincide with the deepest point in your lake and your permanent sampling location.

9. Write a description of the objects used for establishing the bearing lines onto your lake map and in the column on the left.

10. To get the most reliable data, use these same bearing lines each time you take a sample.

5. Level I Sampling Intructions

The following instructions are provided to ensure that all Level I monitors collect data in the same manner. By following these procedures, data collected by different volunteers can easily be compared and contrasted.

These instructions will help you understand how to collect and record your data correctly. Please read them thoroughly. Proper data collection and entry will help staff by eliminating discrepancies and ambiguities in your data. Proper record keeping also makes it easier for staff to enter your data into the database, report the data in the program's newsletter, and analyze the data for the annual report as well as for trends over time.

As a Level I monitor you will:

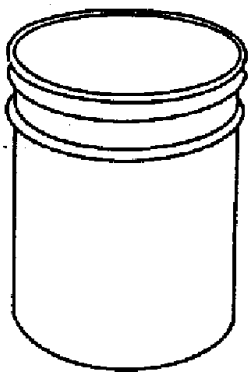
- Measure lake level and precipitation on a daily basis from your property or a specific site you have chosen on the shoreline.
- Measure Secchi depth and lake temperature on a weekly basis from your boat while anchored at your designated lake sampling location.
- Record observations and any unusual conditions on the datasheet.
- Report troublesome conditions to Lake Stewardship staff.
- **Optional:** Count the number of geese you see.

Level I Monitoring Equipment

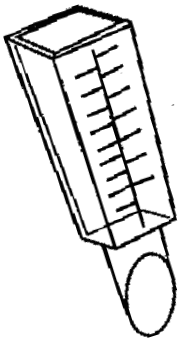
Your Level I sampling kit should contain the below equipment.

Note: You will need to supply your own boat, anchor and life preserver.

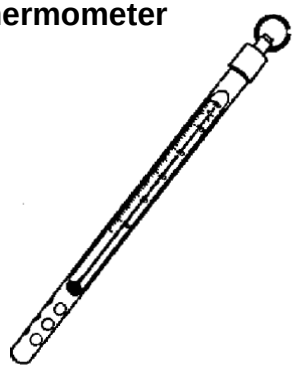
Bucket



Rain Gauge

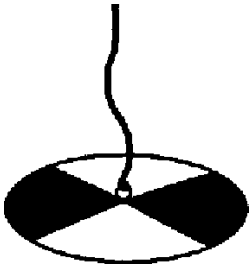


Thermometer

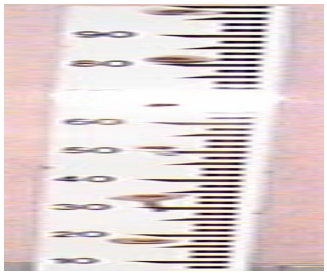


Manual

Secchi Disk



Lake Level Gauge



Data Sheets

Record Initial Data

Conduct your daily measurements at the same time each day, if possible. For weekly measurements, conduct them on the same day of the week and at the same time of day. The most important thing to remember is to be consistent from day to day and from week to week. For the weekly sampling trip:

1. Gather your sampling gear, anchor, and life jacket in your boat. Go to your sampling station and anchor your boat (see "Sampling Location" section, pages 11-12).

2. Use a #2 pencil to record data on the data sheets. Fill out your name, lake name, phone, date, and time on the data sheet.

3. Under "Time," enter the time using a 24-hour time format: 6 a.m.= 0600, Noon =1200, 6 p.m.=1800, and Midnight=2400.

4. In the space provided on the data sheet, indicate cloud cover, wind conditions, and optional goose counts. In the "Lake Use" column, indicate the total number for each category, include your boat in the count. In the comment column, make notes on other items of interest or unusual conditions.

5. If for some reason you are unable to record your measurements, leave it blank. If you are going to be away for more than a few days, try to arrange for a substitute.

Measure Secchi Depth

Did you know?

The Secchi disk is named for Jesuit priest, Pietro Angelo Secchi, an Italian astronomer and astrophysicist who was the director of the observatory of the Gregorian University in Rome in 1849 and a scientific advisor to the Pope. The "Secchi disk" was first used to measure transparency in the Mediterranean Sea on April 20, 1865.

1. On sunny days, work on the shady side of the boat to eliminate glare.

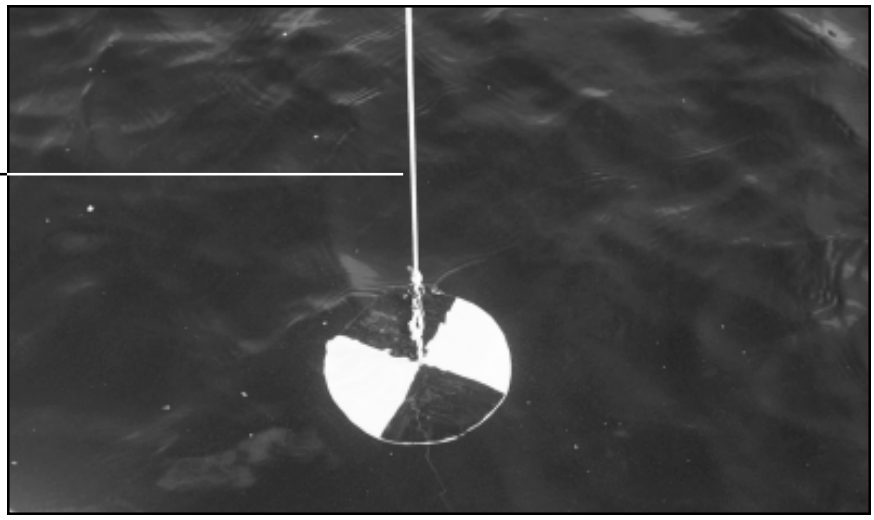
2. If you are wearing sunglasses, remove them before you begin making your measurements.

3. The Secchi disk line is marked in 0.1 or 0.25 meter increments. Lower the Secchi disk into the water. Continue lowering the disk into the water until the disk is no longer visible.

4. Place your finger on the line at the water's surface to mark that point.

5. Raise the disk until it becomes visible again. Mark this spot on the line with your other hand.

6. Record the midpoint between these two measurements as the Secchi depth, estimating your value to the nearest 0.1 meter.

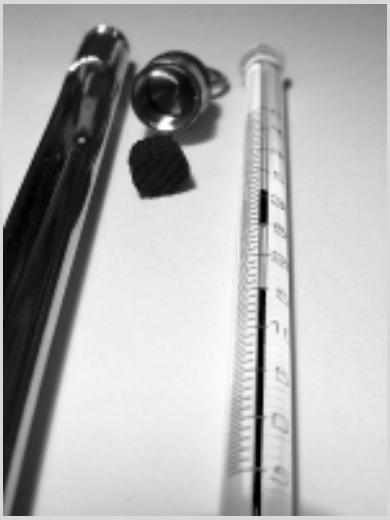


The Secchi disk line is marked in 0.1 meter increments.

Measure Temperature

1. Take your temperature measurement at the same location as the Secchi depth measurement.
2. Measure lake temperature by lowering the thermometer to one meter below the surface and leaving it for approximately two minutes. Pull the thermometer from the water quickly and read it immediately.
3. Record the lake temperature on your data sheet under "Temp" to the nearest 0.5 degrees Celsius (Centigrade).

Important!



If the fluid in the thermometer separates, temperature readings will not be accurate.

See Appendix C for instructions on recombining the fluid.

If the fluid will not recombine, contact a Lake Stewardship Program staff member to request a replacement.

Observe Algae and Particles

Each time you venture onto the lake to collect a sample and/or measure physical attributes, record the density of algae and particles you see in the water at your sampling site. Use the following guidelines when making your observations of algae and particles density and distribution.

Categorizing Visible Algae

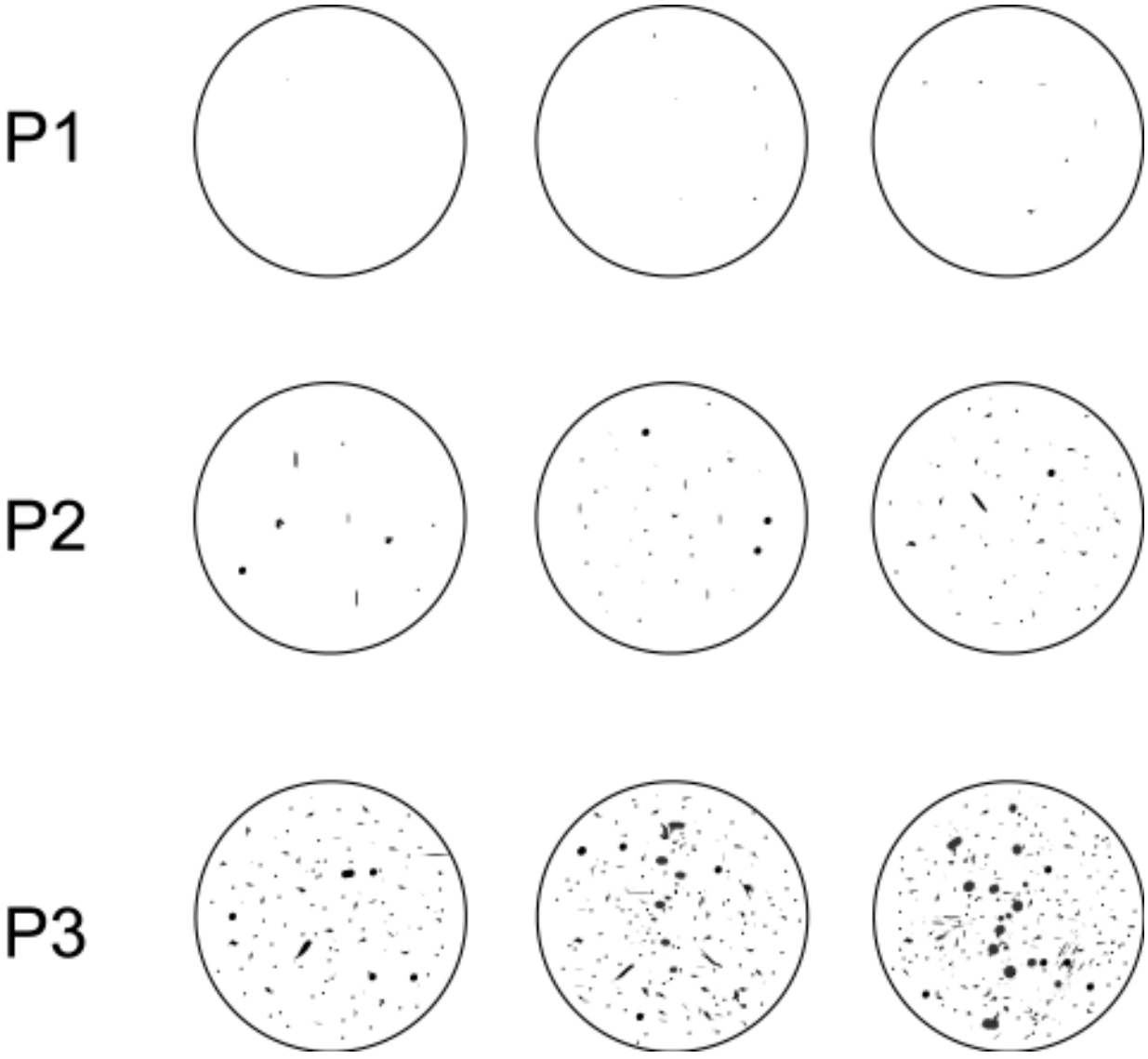
Algae in the water can appear as nebulous clouds or as small floating particles, depending on the species. Lower the Secchi disk to a depth of about six inches below the surface at which depth the volume of water above the disk will be approximately two liters. Look at the water above it against the white portions of the disk. Alternately, you can pour two liters of water into a clean white bucket to make the assessment.

Use the chart on the next page as a guide in making your observations of algae along the shoreline and at your sampling site.

Algae and Particle Classification Chart

Rating	Description	Count in ~ 2L of Water
P1	Few algae particles visible above the Secchi disk.	0 - 10
P2	Moderate numbers of particles.	10 - 100
P3	A lot of algae — bloom conditions.	> 100

Imagine looking into a white bucket with two liters of water from above.



Nuisance Goose Count

Citizens who live on several King County lakes have noted large numbers of Canada geese on their lakes. Counting the number of geese you see will give us a general idea of how many geese are present at a lake and when. This information can then be used to assess the likelihood of geese contributing to water quality issues and what can be done about it.

Recording goose count data is optional. If you do not see large numbers of geese on your lake or do not perceive them as a problem, it is unnecessary to record goose counts. If you do want to participate in the goose count, please choose **one** option below. We are unable to compare data from multiple counting methods, so please choose the option that is best suited to your time commitment for the entire season and then inform the Lake Steward Program staff of your choice.

Choose one of the following three options.

1. **Daily count for Level I Monitors:** If you choose to do a daily count, record the greatest number of geese you see **at once** anywhere on the lake, at any time of day. For example, if you see 10 geese in the morning, eight at noon and 14 in the evening, record "14." Do **not** add up the total number of geese you've seen throughout the day. This method will provide the most thorough goose population information for each lake.

2. **Weekly count for Level I Monitors:** Every week, record the greatest number of geese you've seen at once anywhere on the lake, over the past week. For example, if you see five geese on Monday morning, 15 on Tuesday morning, 12 Tuesday evening and 10 on Friday, you would record "15" on your data sheet for that week. Do **not** add up the total numbers of geese you've seen throughout the week.

3. **Bi-weekly count for Level II Monitors:** On each data sheet write down the largest number of geese you've seen anywhere on your lake **at one time** over the past **one** week (not two). This way we'll be able to compare Level I weekly and Level II goose counts. For example, if you see five geese on Monday morning, 15 on Tuesday morning, 12 Tuesday evening and 10 on Friday, you would write "15" on your data sheet for that week. **Do not** add up the numbers of geese you see at different times.

Lake Level
Gauge Location

Latitude:

N_ _ ° _ _ . _ _ ’

Longitude:

W_ _ _ ° _ _ . _ _ ’

Location Description:

_____

_____

_____

Measure Precipitation

1. Install your rain gauge in an area open to the sky and away from overhanging objects (such as trees or buildings).
2. Try to read your gauge at the same time each day and record the total rainfall in millimeters. Record this number in the "Precipitation" column and then empty your gauge.
3. If you collect snow in your rain gauge, take it inside, allow the snow to melt, and then enter the data. If extended freezing occurs, make sure your rain gauge is empty or take it inside until temperatures rise above freezing, otherwise the gauge may crack. Also, be sure to write "frozen" on your data sheet for these dates.

Measure Lake Level

1. Staff will assist you in identifying a place on your dock or other permanent fixture in the lake to locate your lake level gauge. Complete installation instructions for your lake level gauge are found in Appendix B.
2. Try to record your lake level at the same time each day. Record this number in centimeters on your data sheet in the "Lake Level" column. On windy days, you may have to estimate the approximate lake level by taking an average of the high or low marks created by each wave.

Completed Data Sheet

1. At the end of each month, make a copy of your data sheet for yourself and mail in the original so that we can report the data in The Lake Steward, the Lake Stewardship Program's quarterly newsletter, and the King County Lake Monitoring Report.
2. Please verify that you have filled in your name and contact information.

Level One Weekly Datasheet

Week Of	Date Recorded	Time (24:00)	Secchi Depth (m)	Temp. ^{0}C (at 1m)	Cloud Cover	Wind Conditions	Algae and Particle Count		Optional Goose Count	Lake Use	Comments
							Shoreline	site			
4-Apr-04					☐ Sunny	☐ None (glassy water)				Boats	
					☐ Pt. Cloudy	☐ Slight (ripples)				Fishing	
					☐ Cloudy	☐ Breezy (small wavelets)				Swimmers	
					☐ Raining	☐ Stormy (waves/whitecaps)					
11-Apr-04					☐ Sunny	☐ None (glassy water)				Boats	
					☐ Pt. Cloudy	☐ Slight (ripples)				Fishing	
					☐ Cloudy	☐ Breezy (small wavelets)				Swimmers	
					☐ Raining	☐ Stormy (waves/whitecaps)					
18-Apr-04					☐ Sunny	☐ None (glassy water)				Boats	
					☐ Pt. Cloudy	☐ Slight (ripples)				Fishing	
					☐ Cloudy	☐ Breezy (small wavelets)				Swimmers	
					☐ Raining	☐ Stormy (waves/whitecaps)					
25-Apr-04					☐ Sunny	☐ None (glassy water)				Boats	
					☐ Pt. Cloudy	☐ Slight (ripples)				Fishing	
					☐ Cloudy	☐ Breezy (small wavelets)				Swimmers	
					☐ Raining	☐ Stormy (waves/whitecaps)					
					☐ Sunny	☐ None (glassy water)				Boats	
					☐ Pt. Cloudy	☐ Slight (ripples)				Fishing	
					☐ Cloudy	☐ Breezy (small wavelets)				Swimmers	
					☐ Raining	☐ Stormy (waves/whitecaps)					

Algae and particles: No algae or other particles (NA) 1-10 particles (P1) 10-100 particles (P2) over 100 particles (P3) Count all particles on 1/4 Secchi disk at 6 inches dee

Lake Marcel

Knowing trees, I understand the meaning of patience. Knowing grass, I can appreciate persistence.

— Hal Borland (1900-1978)

6. Level II Sampling Instructions

This section provides Level II Monitors with an overview of monitoring equipment, data recording, and sampling methods. This information is provided to ensure that all Level II Monitors collect data in the same manner and at the same intervals. By following the same sampling methods each time, data collected by different volunteers can be easily compared and contrasted.

Proper data collection and entry reduces ambiguities and discrepancies when staff enter collected data into the database, report the data in The Lake Steward, the Lake Stewardship Program's quarterly newsletter, and analyze the data for the King County Lake Monitoring Report.

From late April through October, Level II Monitors will collect water samples every other week, as well as read the Secchi depth and water temperature of the lake. The water samples are analyzed for:

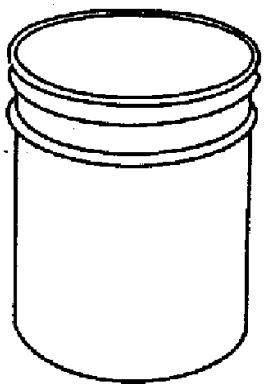
- nitrogen,
- phosphorus,
- chlorophyll *a*,
- and phytoplankton species present.

Level II Monitoring Equipment

Your Level II sampling kit should contain the below equipment.

Note: You will need to supply your own boat, anchor, and life preserver.

Bucket

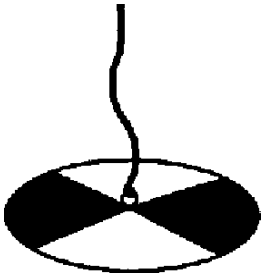


Manual

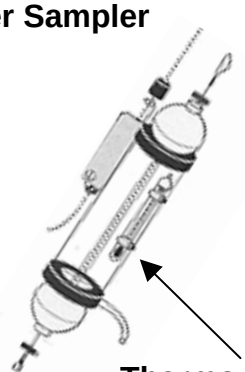
Sample Bottles

Data Sheets

Secchi Disk



Water Sampler



From Collection to Reporting: The Journey of Level II Water Samples

STEP 1: Sampling
Volunteer lake monitors collect observational data and water quality samples on an assigned day. They use prelabeled, clean bottles provided by the Lake Stewardship Program.

STEP 2: Pick-Up
Lake Stewardship Program staff pick up samples and data sheets from volunteers' homes and leave new bottles for the next sample date. Phytoplankton samples are preserved at the time of pick up and samples are kept cool and protected. Any unusual conditions are noted.

STEP 3: Environmental Lab Analysis
Data sheets and water samples for chemistry analysis are delivered and logged into the King County Environmental Laboratory. Sample dates and times are checked for consistency. Any unusual conditions are noted.

STEP 4:
Phytoplankton Sample Analysis
Phytoplankton samples are mailed to Water Environmental Services, Inc., a consulting group, that identifies algae in each sample, measures cell sizes and estimates numbers. The data are summarized and sent to the county to be entered into spreadsheets for analysis and graphing. The consultant cleans the sample bottles and returns them to King County for re-use.

STEP 5: Quality Control
The lab chemistry staff follow strict protocol for sample holding times and quality assurance of chemical analysis. Staff include "blanks," "standards," and "spikes," — predetermined sample values — in all batches being analyzed to test reliability of the chemical analyses and ensure quality.

STEP 6: Data Entry & Storage
After lab analysis, all sample values are examined for consistency. Once its quality is assured, data are entered into a King County database for further analysis. The time between receiving samples and database entry is less than 30 days. Excess water samples are frozen and kept for 90 days, for further analysis as needed.

STEP 7: Data Review
Using the King County database, Lake Stewardship Program staff review data for entry errors and internal consistency on a lake-by-lake basis. Anomalies are discussed with the Environmental Lab and if necessary, samples are re-analyzed.

STEP 8: Data Reporting
At the end of the season, sample values are finalized for the year. Graphs are made of the data parameters and compared with previous years, with the results published herein. The King County Lake Monitoring Report is distributed to volunteers, libraries, scientists, government and environmental agencies and other stakeholders interested in the water quality of King County's small lakes.

Record Initial Data

The most important thing to remember is to be consistent in how samples are collected, measurements are taken and data is recorded. Whenever possible, conduct your biweekly sample collection and measurements at the same time of day.

1. Place sampling gear, anchor, and life jacket in the boat. Go to the sampling station and anchor the boat. (See Sampling Location on page 11 for instructions if needed.)

2. Use a #2 pencil to record data on the weather proof data sheet. Fill out the sheet for Name, Phone, Date, and Time. Under "Time," enter the time the data was measured and the water samples were taken using a 24-hour time format (6:00 a.m. = 0600, Noon = 1200, 6:00 p.m. = 1800, and Midnight = 2400).

3. Write down the weather conditions, the presence or absence of algae and the optional bird count. Also indicate the total number of boats on the lake, including your own.

4. If for some reason you are unable to collect water samples and take measurements, please notify a Lake Stewardship Program staff member at least two days in advance, so we can avoid making an unnecessary trip to your lake to pick up your samples. If possible, try to arrange for a substitute whenever you are going to be away for an extended period of time.

Measure Secchi Depth

1. On sunny days, work on the shady side of the boat to eliminate glare.

2. If you are wearing sunglasses, remove them before you begin making your measurements.

3. The Secchi disk line is marked in 0.1 or 0.25 meter increments. Lower the Secchi disk into the water. Continue lowering the disk into the water until the disk is no longer visible.

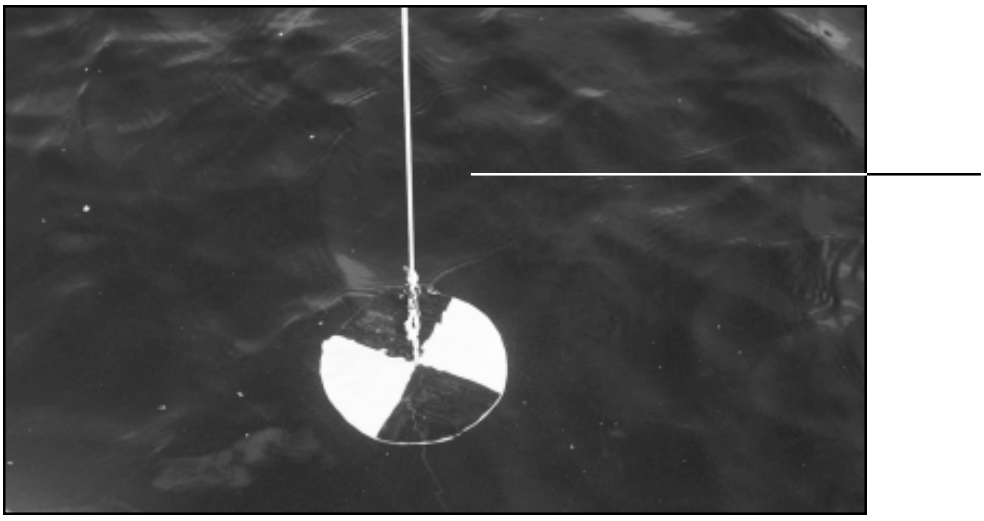
4. Place your finger on the line at the water's surface to mark that point.

5. Raise the disk until it becomes visible again. Mark this spot on the line with your other hand.

6. Record the midpoint between these two measurements as the Secchi depth, estimating your value to the nearest 0.1 meter.

Did you know?

The Secchi disk is named for Jesuit priest, Pietro Angelo Secchi, an Italian astronomer and astrophysicist who was the director of the observatory of the Gregorian University in Rome in 1849 and a scientific advisor to the Pope. The "Secchi disk" was first used to measure transparency in the Mediterranean Sea on April 20, 1865.



The Secchi disk line is marked in 0.1 meter increments.

Observe Algae and Particles

Each time you venture onto the lake to collect a sample and/or measure physical attributes, record the density of algae and particles you see in the water at your sampling site. Use the following guidelines when making your observations of algae and particles density and distribution.

Categorizing Visible Algae

Algae in the water can appear as nebulous clouds or as small floating particles, depending on the species. Lower the Secchi disk to a depth of about six inches below the surface at which depth the volume of water above the disk will be approximately 2L. Look at the water above it against the white portions of the disk. Alternately, you can pour 2L of water into a clean white bucket to make the assessment. Use the chart on the following page as a guide in making your observations of algae along the shoreline and at your sampling site.

Rinse the Sample Bottles

1. Rinse all bottles before collecting samples.

2. To thoroughly rinse a bottle, remove the top, dip the bottle into the lake to fill the bottle approximately 1/4 full, swirl the water around the bottle to cover all surfaces, and pour the water back into the lake.

3. Repeat this three times for each bottle. On the third rinse, use the water to rinse the cap of the bottle.

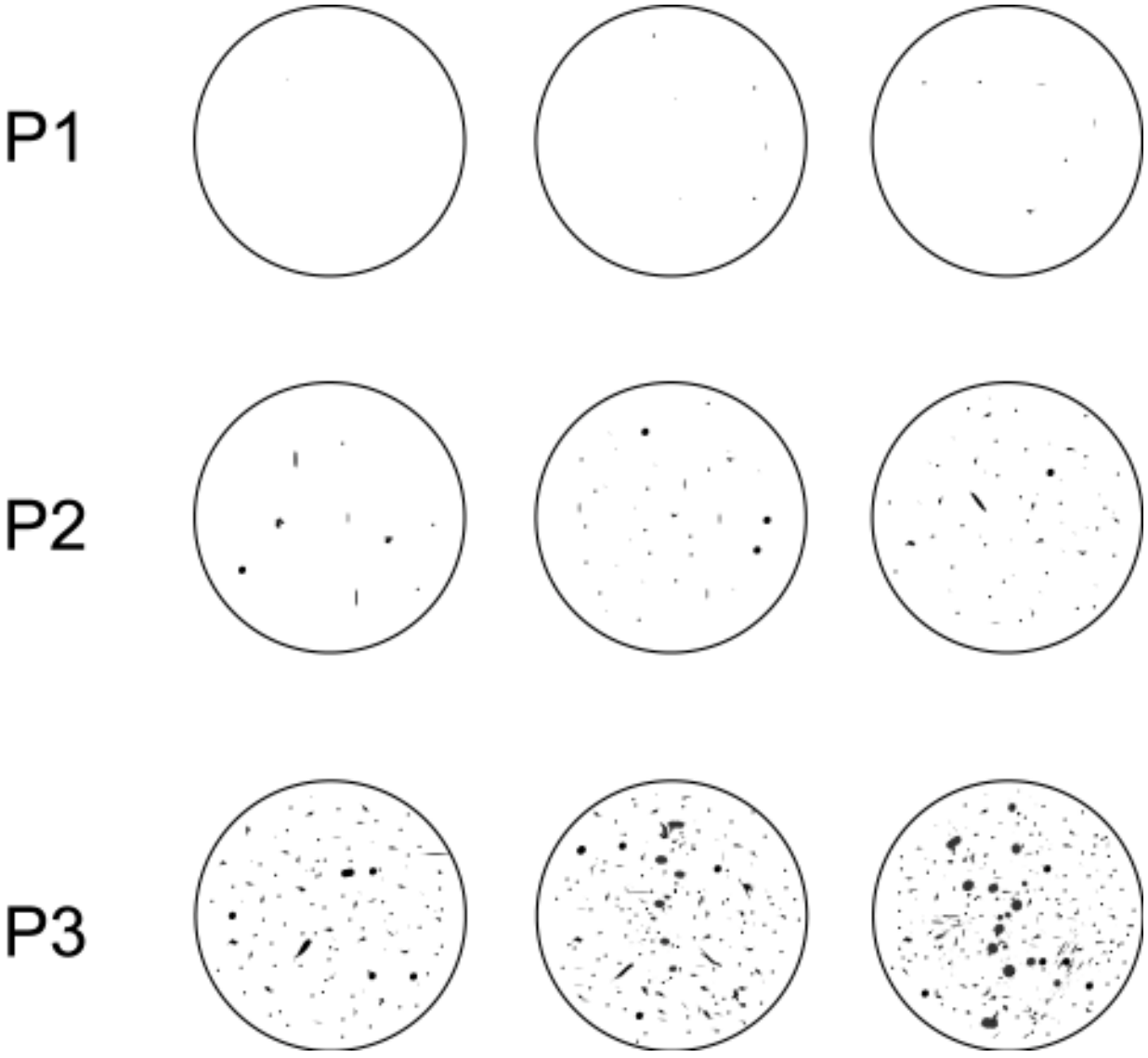
4. Replace the cap and leave it on until just before you fill it with the sample.

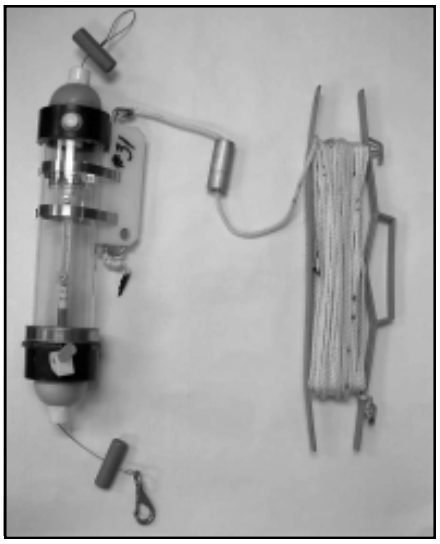
5. If there is any material visible on or near the water surface, such as pollen or algae, rinse the Van Dorn sampler first (as described in the following paragraph), and then use water from your first sampler drop to rinse the bottles one more time.

Algae and Particle Classification Chart

Rating	Description	Count in ~ 2L of Water
P1	Few algae particles visible above the Secchi disk.	0 - 10
P2	Moderate numbers of particles.	10 - 100
P3	A lot of algae — bloom conditions.	> 100

Imagine looking into a white bucket with two liters of water from above.



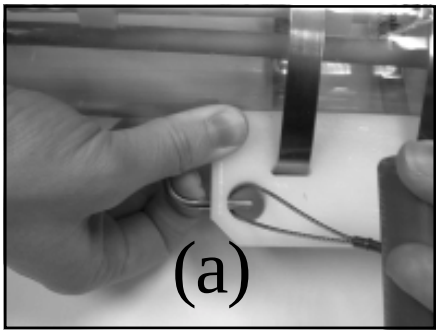


Rinse the Van Dorn Sampler

1. While sitting, lay sampler across your knees so you can see the thermometer inside.

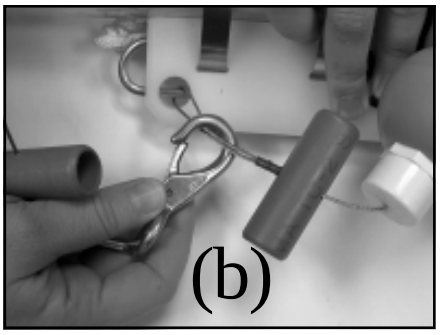
2. With one hand, pull the rubber ball with loop only (no clip attached) out of the tube and hold tightly. With the other hand pull the brass rod (see photo “a”) and insert the cable loop (see photo “b”) into the hole located near the bottom of the large white closing mechanism. Release the rod to hook the loop.

2. Then pull the bottom ball toward the top ball and hook the clip around the entire cable loop (include both wires) from the top ball. The sampler is now set.



3. Open the small plastic clamp on the drain tube near the bottom of the sampling chamber. Ensure that the clamp is not too close to the end of the drain tube.

4. To rinse the sampler, set the sampler as described above. Keep the messenger with you on the boat and lower the sampler to a depth of about one-meter. Gently raise and lower the sampler several times so that water passes through the open chamber of the sampler to rinse it. Do not drop the brass messenger.



5. Raise the sampler to the boat, letting all the water drain out, close the drain tube clamp.

You are now ready to collect your samples.

Collect Water Samples

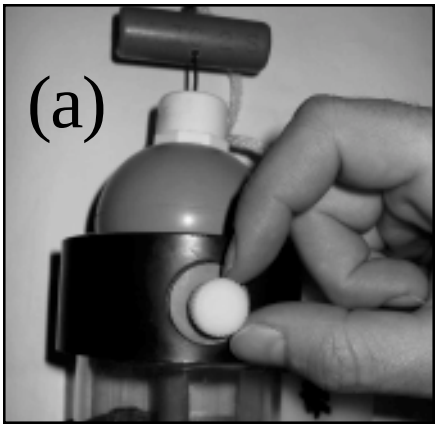
1. To obtain a sample at one-meter depth, hold the brass messenger and gently lower the sampler vertically into the lake so that the one-meter mark is just visible at the water surface. Release the messenger to activate closure of the sampler.

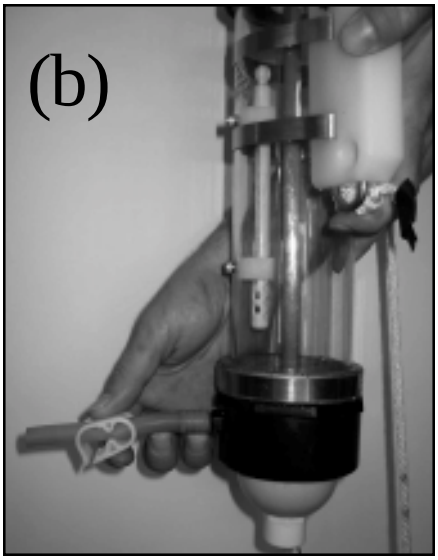
2. Bring sampler to boat and hold vertically. If there is a small white round valve (see photo “a”) on top of the sampler, turn it to relieve pressure, then open the clip (see photo “b”) on the surgical tubing to empty the water from inside the cylinder. Direct the water from the tube into the sample bottles, filling the bottles to the neck. You will need to fill the sampler at least twice to fill all the bottles.

3. Before emptying water from the second sampler drop, let the water sit for about one minute and read the water temperature from the thermometer located inside the sampler and record it on the field sheet (__°C @1m to the nearest 0.5°).

4. Reset the sampler and collect water at a depth of one-meter until you have filled each of the bottles. Twice should suffice unless you have duplicate bottles to fill.

5. Place samples immediately in a cooler filled with ice. If you cannot fit a cooler into your boat, return home and place the samples in a cooler filled with ice as soon as possible or in the refrigerator overnight until setting them out for pickup the following day.





2004 Level II Monitoring Data Sheet

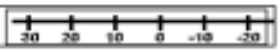
PLEASE FILL IN ALL INFORMATION

Volunteer Monitor: _____ **Phone:** _____

Sample Collected: Sunday / Monday _____ at _____ **Lake:** _____
(Circle day) (Date) (24hr Time)

Sample at One Meter

TEMPERATURE



At one meter: _____°C (to the nearest 0.5°C)

Profile Sample Events (May 23, 24 and Aug. 29, 30):

at ____m depth: _____°C (mid depth)

at ____m depth: _____°C (near-bottom depth)

SECCHI DEPTH

Secchi Depth: _____ m (to nearest 0.10m)

Notes: _____

Mid-depth Sample (or 1m Duplicate)

WEATHER

- ❒ Sunny
- ❒ Partly cloudy
- ❒ Overcast
- ❒ Dark clouds
- ❒ Raining
- ❒ No wind (glassy water)
- ❒ Slight wind (small ripples)
- ❒ Breezy (small wavelets)
- ❒ Stormy (waves/whitecaps)

Rain last 24hr (mm):____

Do not take a mid-depth or duplicate sample unless a label is affixed here.

(Profiles: May 23, 24 and Aug. 29, 30)

ALGAE PARTICLE COUNT

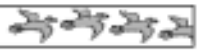
Algae at your sampling location: P1 P2 P3
(Circle One)

Unusual algae conditions:

_____

Near-bottom Sample

OPTIONAL GOOSE COUNT



Greatest number of Canada geese on your lake at any one time in the last week?_____

Other geese observations?

Do not take a near-bottom sample unless a label is affixed here.

(Profiles: May 23, 24 and Aug. 29, 30)

LAKE USE

Number of boats on lake: _____

Notes: _____

Please provide any other information on the back of this sheet. THANK YOU!

KING COUNTY

Questions? Please contact Michael Murphy at (206) 296-8008 or *michael.murphy@metrokc.gov*

Storing Monitoring Equipment and Sample Pick-up

1. To store the sampler, wedge the clip under the ball so air can circulate inside the sampler to dry it before your next trip. (For additional information about equipment maintenance and repair, please see Appendix C.)

2. The next morning, if your samples have been stored in the refrigerator transfer them to a cooler filled with ice. Be sure to check the ice level in your cooler and replenish it if necessary. Then, place the cooler and your data sheet at your designated pick-up location.

3. The samples will be picked up by staff and new bottles left for the next sampling date.

4. If you miss a sample date, return the empty bottles and blank data sheet with your next samples. Staff will drop off or mail new bottles to you prior to the next sampling date.

Quality Assurance

The quality of the data collected through the Volunteer Monitor program depends on the level of adherance to the standard collection methods provided in this manual. Follow the below instructions to ensure the quality of the data.

1. Sample at the same location and anchor your boat to prevent drifting.

2. Fill out the data sheet completely and note unusual observations or conditions.

3. Check the labels on the sample bottles to make sure they have the correct lake name, date, and sample depth. Make sure the date on the labels matches the date on your data sheet. Important: If you sample on a different date than listed on the labels

of the bottles, change the date on the labels to reflect your actual sample collection date.

4. Sample the same way and generally at the same time (between 2 p.m. and 5 p.m. if possible).

5. Rinse the sampler completely before you begin.

6. Rinse the plastic sample bottles three times before filling with water for proper analysis.

7. Keep your fingers out of the sampling equipment and bottles and hold the bottle caps by their edges only.

8. Sample at one-meter depth unless otherwise instructed.

9. Fill bottles to the neck only (not full to the lip) and cap tightly.

10. Store your samples in an ice chest or refrigerator until pick-up.

11. Call Lake Stewardship Program staff when you cannot sample or arrange to have a back-up monitor collect samples when you are unavailable. Lake Stewardship Program staff are readily available to train back-up monitors upon request.

All samples are picked up and delivered to the King County Laboratory in Seattle. Samples should be preserved and/or analyzed within 24-48 hours; otherwise the analysis results are unreliable.

Laboratory staff adhere to additional quality assurance procedures for water samples, including logging samples, reviewing data sheets, verifying lab work orders, and distributing the samples for analysis. Lab staff also track samples, analyze data, and report final results. To provide quality assurance, the lab will “split” some samples in two and analyze the samples separately to measure the variability associated with the lab analysis.

Profile and Field Replicate Sampling

Standard sampling methods should be followed during all sampling sessions with two exceptions. First, once in May and again in September, you will collect lake profile samples from two or three depths – surface, mid-lake depth, and near-bottom – depending on the total depth of your lake. Read the labels on the bottles to determine sample depths.

Second, you may be asked during one sampling session to collect a field replicate of your samples to ensure that sampling procedures are consistent and to look at variability. Field replicates are samples collected at the same location but analyzed separately. If there is little sampling variability, the replicate sample should closely match the original sample data. Advance notice and additional instructions will be included with your sample bottles when these exceptions occur.

Sampling Schedule

The Lake Stewardship Program staff coordinate sampling for volunteers at over 50 lakes. This requires significant time and planning. The sampling schedule, established in advance with the King County Laboratory, requires that you sample either on Sundays or Mondays. Staff will collect samples and field sheets and deliver new sample bottles to you the day after you sample.

Our quality assurance methods require that samples be analyzed within 24-48 hours of collection. Therefore, following the schedule is very important to ensure that samples are delivered to the laboratory in a timely manner. Always place water samples on ice and leave them at the predesignated pick-up location.

Please notify program staff if you are unavailable to sample on a scheduled day. With enough notice, we can switch your sampling day for that week. However, if you are unavailable on both Sunday and Monday, please make arrangements with a back-up monitor to have the water samples collected and left (on ice) at the designated pick-up location. This will ensure we have a complete data set for the lake.

2004 Monday Pick Up Schedule

[ ] Sample Day ⬡ Pick-up Day

If you need to change your sample or pick-up date, please contact: Michael Murphy at 206-296-8008, michael.murphy@metrokc.gov or Katie Messick at 206-296-0516, katie.messick@metrokc.gov.

April

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
[25]	⬡26	27	28	29	30	

May

Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
2	3	4	5	6	7	8
[9]	⬡10	11	12	13	14	15
16	17	18	19	20	21	22
[23]	⬡24	25	26	27	28	29
30	31					

June

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4	5
[6]	⬡7	8	9	10	11	12
13	14	15	16	17	18	19
[20]	⬡21	22	23	24	25	26
27	28	29	30			

July — Note schedule change due to holiday.

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	[5]	⬡6	7	8	9	10
11	12	13	14	15	16	17
[18]	⬡19	20	21	22	23	24
25	26	27	28	29	30	31

August

Sun	Mon	Tue	Wed	Thu	Fri	Sat
[1]	⬡2	3	4	5	6	7
8	9	10	11	12	13	14
[15]	⬡16	17	18	19	20	21
22	23	24	25	26	27	28
[29]	⬡30	31				

September

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2	3	4
5	6	7	8	9	10	11
[12]	⬡13	14	15	16	17	18
19	20	21	22	23	24	25
[26]	⬡27	28	29	30		

October

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3	4	5	6	7	8	9
[10]	⬡11	12	13	14	15	16
17	18	19	20	21	22	23
[24]	⬡25	26	27	28	29	30
31						

2004 Tuesday Pick Up Schedule

[ ] Sample Day ⬡ Pick-up Day

If you need to change your sample or pick-up date, please contact: Michael Murphy at 206-296-8008, michael.murphy@metrokc.gov or Katie Messick at 206-296-0516, katie.messick@metrokc.gov.

April

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	[26]	⬡27	28	29	30	

May

Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
2	3	4	5	6	7	8
9	[10]	⬡11	12	13	14	15
16	17	18	19	20	21	22
23	[24]	⬡25	26	27	28	29
30	31					

June

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4	5
6	[7]	⬡8	9	10	11	12
13	14	15	16	17	18	19
20	[21]	⬡22	23	24	25	26
27	28	29	30			

July — Note schedule change due to holiday.

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4	5	[6]	⬡7	8	9	10
11	12	13	14	15	16	17
18	[19]	⬡20	21	22	23	24
25	26	27	28	29	30	31

August

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	[2]	⬡3	4	5	6	7
8	9	10	11	12	13	14
15	[16]	⬡17	18	19	20	21
22	23	24	25	26	27	28
29	[30]	⬡31				

September

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2	3	4
5	6	7	8	9	10	11
12	[13]	⬡14	15	16	17	18
19	20	21	22	23	24	25
26	[27]	⬡28	29	30		

October

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3	4	5	6	7	8	9
10	[11]	⬡12	13	14	15	16
17	18	19	20	21	22	23
24	[25]	⬡26	27	28	29	30
31						

Appendix A

The Chinese Mystery Snail

The Lake Stewardship Program is working to assess the presence, population and lake locations of the Chinese mystery snail (*Cipangopaludina malleata* var *chinensis*) in King County. If you see a snail similar to the one identified in the photo on the right, please contact a staff member from the Lake Stewardship Program (p. v).

Let the Lake Stewardship Program staff know if you see the Chinese mystery snail in your lake. Its greenish-brown shell is placed next to a dime in this photo to show its size.

Recently, the Chinese mystery snail has been identified at Wilderness, Spring, Desire and Sawyer lakes. However, the Chinese mystery snail was first documented in the Pacific Northwest more than forty years ago, but very little has been written about its introduction nor have its impacts on native snails or ecosystems of local lakes been studied since then. The Chinese mystery snail was reported living in Seattle's Green Lake in the 1960s, in addition to a lake in the San Juan Islands.

Anecdotal reports as far back as 1892 suggests that the snail was offered for sale as a food item in Chinese markets in both San Francisco and Vancouver, BC. However, it is equally likely that it was introduced into local waters from hobby aquariums emptied into nearby ponds and lakes. The snails are offered in pet stores for controlling algal growth on the glass walls of aquariums and

for reducing the accumulation of litter by their habit of feeding on bottom detritus.

The Chinese mystery snail is popular with hobbyists because their large size makes them very conspicuous, as well as less likely to be eaten by pet fish (especially compared with much smaller native freshwater snail species). Their size also makes them easy to see in the shallow water of lakes. They appear to prefer the warmer water near shorelines and can be seen, when the water is clear, inching along the bottom looking for food.

In addition to their size, other identifying characteristics include the smooth outside of the thin shell, its greenish-brown color, and a hard covering of the shell hole called the operculum. The Japanese mystery snail (*Cipangopaludina japonica*), a similar species about which even less is known, may also be present in some local lakes. It looks very similar, but can be distinguished by subtle differences in shell characteristics.

While they may be eaten routinely in some parts of Asia (one Web site offers a recipe for, "Mystery Snails in Wine Sauce"), the lack of information about the snail's hosting of parasites should make the would-be gourmet pause before gathering and cooking them. In their native habitat, they are known to harbor parasites such as flukes and schistosomes (the parasite group responsible locally for swimmer's itch). Eating the snails is definitely not recommended until more is known.

Describing the impact these snails have had on native species may prove a difficult task. Various local lakes have been managed in the past for fish communities, sometimes with little known about the effects that management techniques might have on other animals living in the water. For example, several lakes were treated with toxic chemicals such as rotenone to kill off nuisance fish species, which could have also affected other animal species. The introduction of the Chinese mystery snail might have been into environments that were already under extreme stress.

Appendix B

Lake Level Gauge Installation

The depth of a lake naturally fluctuates as seasons change. In the Pacific Northwest, most rainfall occurs from late fall through spring. During the dry summer season, water levels drop and most lakes will be at their lowest point between September and October. As rainfall increases through the winter, water levels rise and usually peak in January or February. The difference between the peak of winter and the low point of fall is generally less than one meter.

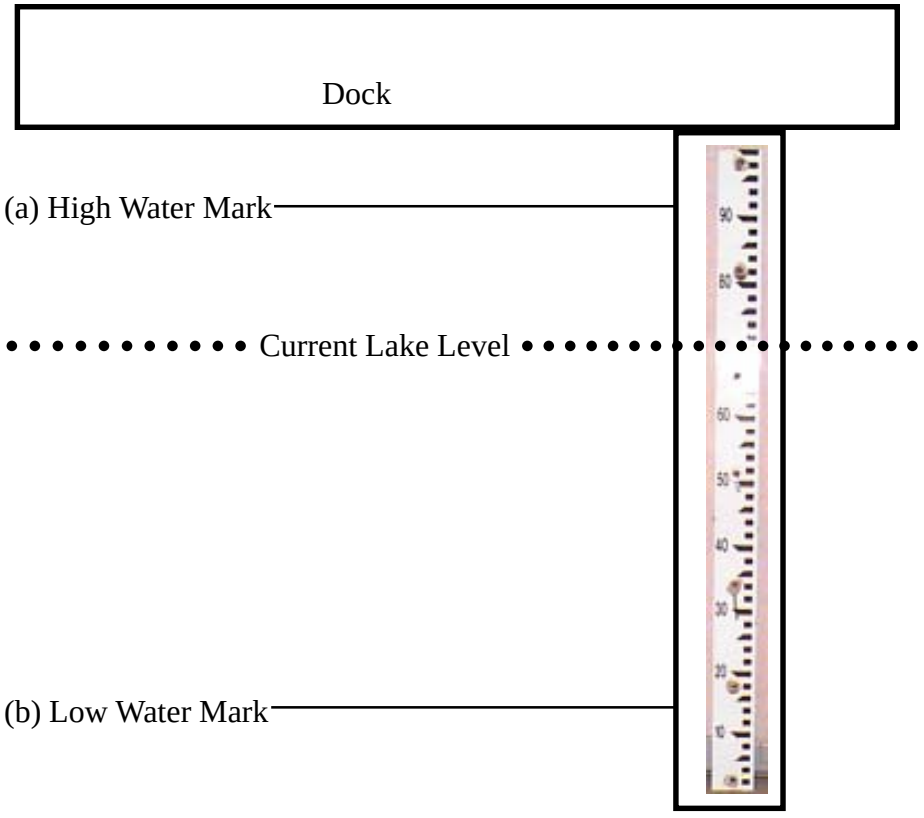
The lake level gauge provided is one meter long and should accommodate the fluctuation of water levels at your lake. The gauge should be mounted to a dock in such as way as to handle the peak levels of winter and the low levels of early fall. (See Figure 1 on the next page.) **If you know your lake fluctuates more than one meter, discuss alternative measurement methods with the Lake Stewardship Program staff.**

If there are lake level gauges at other locatons around your lake, set your gauge at the same level (on a calm water day).

1. Identify a fixed object such as a dock piling or a 2x4 post that is well anchored in the lake bottom. Do not attach the gauge to a floating structure that rises and drops with the water level.

2. Identify a high water mark (a) on the dock or another post where the gauge will be mounted. Locate the top of the gauge (100cm mark) slightly above the estimated high water mark.

3. If installing the gauge during the rainy season, make sure you mount the gauge so that low water marks (b) can also be easily measured.

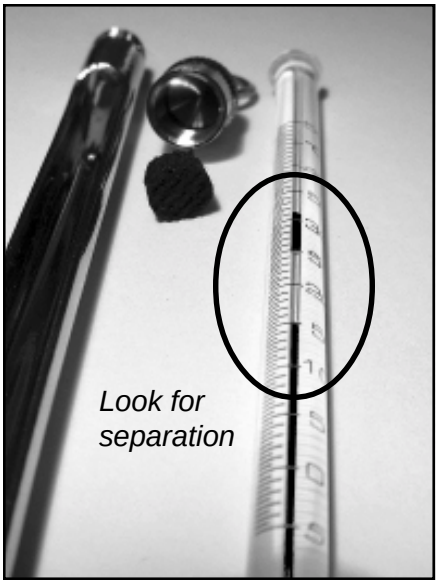


Appendix C

Equipment Maintenance and Repair

Recombining Separated Thermometers

The metal-cased thermometers provided contain alcohol or citrus-based fluid rather than mercury, for environmental and safety reasons. Because the fluid in the thermometers is thinner, it has a tendency to separate, especially if thermometers are shaken or dropped.



Periodically remove the thermometer from the metal case to verify the fluid column is intact. (Be careful not to lose the small cork or foam disc that prevents the thermometer from rotating in its case.) If the thermometer fluid has separated, the readings will not be accurate. **Do not use the thermometer until the problem is corrected.**

You can attempt to recombine the fluid by placing the thermometer in a mixture of salt, ice, and a little water in the freezer for several hours. If the fluid has not recombined, contact one of the Lake Stewardship Program staff for a replacement.

Repairing the Vertical Sampler: Tightening or reattaching latex tube to the rubber ball

It is common for the elastic tubing between the two balls to stretch out with use over time. The elastic tube can also break or separate at the attachment point with the ball. Tightening and/or reattaching the elastic tube is a fairly simple process that can usually be done without tools.

Before starting, it is helpful to know how the samplers work. The latex tubing provides the force that pulls the balls against the ends of the sampling tube, trapping the water when the sampler is tripped. The bungee cord running through the center of the latex tube is a fail-safe to prevent pieces of the sampler from sinking to the bottom of the lake if the latex tube breaks.

To reattach the latex tube to one of the rubber balls, or to shorten the latex tube to eliminate leaks, follow these steps.

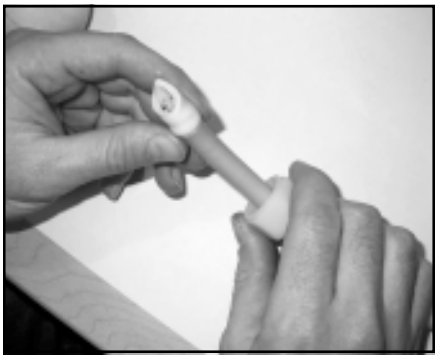
1. Note the placement of the clip and loop at the ends of the sampler. Replace them so that the ball with the clip is at same end as the drain tube.

2. Stretch the balls apart until you can grasp one of the balls in one hand and the plastic cap nut with the bungee cord and elastic tubing in the other. To tighten the elastic tubing, loosen the nut on either ball (but not both). If you need to reattach separated or broken tubing, loosen the nut on the side where the tubing is no longer attached. If you cannot loosen the nut with your hands, use pliers.

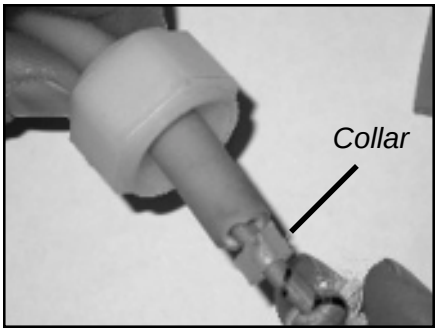
3. Remove the balls and tubing and set the rest of the sampler aside.

4. To reattach broken tubing, begin by threading the tubing through the opening in the nut. To tighten, push the tubing

through the nut so there is a longer tail on the ball-side (also the threaded side) of the nut. This can be difficult. If it is too hard to get the tubing through, cut the end of the tubing at an angle, feed the tip through, and pull the rest through with pliers.



5. Adjust the tubing to the desired length. If you are tightening the sampler to prevent leaks, shorten the tubing until the exposed length of tubing between the plastic nuts is approximately three inches shorter than the length of the sampler tube (without the balls attached). This will differ depending on the overall length of the sampler tube and the elasticity of the latex tubing. Keep adjusting until you find a length that works.



6. You should see a small plastic "collar" that looks like a ¼-inch section of a very thick-walled drinking straw – either around the bungee cord, in a broken section of the tubing, or still in the elastic tube. When this collar is set entirely inside the tubing, it will prevent the tubing from being pulled through the plastic nut, maintaining the desired length of the tubing.

7. When you have the tubing at the desired length, make a mark with a ballpoint pen at the point where the tubing exits the nut. Then pull the tubing through the nut (so there is a long "tail") and slide the collar into the latex tube to a point just above the pen mark. This can be difficult. Use a pen, pencil, or other blunt instrument to help push the collar into the tube. Cutting off some of the excess latex tube might help you get the collar inserted to the desired point.

8. Slide the plastic nut toward the end of the tubing until it is seated against the bulge made by the plastic collar.

9. Once you have the length of the latex tube set, you should have one ball attached to the latex tube, and the other ready to attach.

10. Hold the sampler vertically and rest the attached ball at the appropriate end of the sampler (clip on the same end as the drain tube). The latex tube and nut should dangle down into the sampler tube. If you can, reach into the tube, grab the nut, and stretch the latex tube until you can screw the ball onto the nut. If you cannot reach the nut with your fingers, thread a loop of the sampler rope through the sampler, loop it around the nut, and pull the nut through so that you can reattach the ball.

11. Reattach the ball to the nut, and check the tension of the elastic tube. If the tube is too short, the sampler will be very hard to set. If it is too loose, it will leak after you have collected a sample.

12. Set the sampler, trip it, and readjust the length of the tube if necessary.

Frayed Clip Wires

Another weak point of the samplers is the wire that connects the clip or wire loop to the rubber balls. It is common for the wires to fray or break after about two seasons of use. The best way to prevent this is to catch it before it happens. If you notice that one of the wires is frayed or about to break, please contact one of the Lake Stewardship Program staff to request a replacement on the next pick-up date. If you leave the equipment out with the water samples, the staff will replace the parts. Otherwise, it will be left for you to replace.

It’s Just Broken!

If the sampler breaks and you are unable to fix it, you can still take a sample. Just dip the bottle directly into the lake and fill it from the surface. If there is a lot of pollen or algae collected on the surface, try to wave some of the surface scum away with your hand before dipping the bottle. Make a note on your data sheet that the sampler was broken and you did a “surface dip” to collect the sample.

Appendix D

Glossary

Aerobic: Living in the presence of oxygen. Most organisms are aerobic and must have oxygen available in order to survive.

Algae: Single celled nonvascular plants occurring singly or in groups (colonies). They contain chlorophyll *a*, used to produce their own food by means of photosynthesis. Algae form the base of the food chain in aquatic environments.

Algal Bloom: Heavy growth of algae in and on a body of water, often a result of high nutrient concentrations.

Alkalinity: The acid neutralizing capacity of a solution, usually related to the amount of carbonates present; buffering capacity.

Anaerobic: Living in the absence of oxygen. Some bacteria can survive and grow without oxygen present.

Anoxic: No oxygen present in the system; see anaerobic.

Average: (see "Mean") The sum of a group of numbers divided by the total number of values in the group.

Bathymetric Map: A map showing the bottom contours and depth of a lake.

Benthic: Bottom area of the lake which hosts the community of organisms (benthos) that live in or on the sediment.

Biovolume: Space occupied by organic matter.

Catchment Basin: See "Watershed."

Chlorophyll *a*: A green pigment in plants which is used to capture light energy and convert it, along with water and carbon dioxide, into food or organic material.

Concentration: The amount of one substance in a unit amount of another substance, such as a specific weight of a chemical in a given volume of water.

Conductivity: The measure of water's capacity to convey an electric current. Increasing the numbers of dissolved ions also increases the conductivity.

Dissolved Oxygen: The oxygen gas that is dissolved in water as O_2.

Ecosystem: Any complex of living organisms with all other factors that affect them and are affected by them.

Epilimnion: The warmer, less dense, upper layer of a lake lying above cooler water (metalimnion and hypolimnion) in some seasons of the year.

Eutrophic: Waters containing algae making large populations and biovolumes, generally related to nutrient supply.

Eutrophication: The physical, chemical, and biological changes

associated with enrichment of a body of freshwater due to increases in nutrients and sedimentation.

Fall Turnover: The mixing of thermally stratified waters that commonly occurs during early autumn. The sequence of events leading to a fall turnover includes: cooling of surface waters leading to a density change in surface water that produces convection currents from top to bottom, and circulation of the total water volume by wind action. Turnover generally results in uniformity of the physical and chemical properties of the water.

Humic Substances: Organic substances incompletely broken down by decomposers such as bacteria. Humic acids are large molecular organic acids that are present in water, often giving the water a yellow or brown color.

Hypolimnion: The colder, dense, deep water layer in a thermally stratified lake, lying below the metalimnion and removed from surface influences.

Level I sampling: An annual volunteer monitoring program managed by the King County Lake Stewardship Program. The program involves daily measurements of precipitation and lake level, as well as weekly measurements of surface water temperature and water clarity, and observations on aquatic plant growth, lake use, and numbers of geese throughout the year.

Level II sampling: A seasonal volunteer monitoring program managed by the King County Lake Stewardship Program. The program involves biweekly measurements of surface water temperature and water clarity, collecting water samples for laboratory analysis, and observations on aquatic plant growth, lake use and numbers of geese from late April through October.

Limiting Nutrient: Essential nutrient that is available in the smallest amount in the environment, relative to the needs of the organisms.

Limnology: The study of lakes and inland waters as ecosystems.

Littoral: The shallow region in a body of water which can be inhabited by rooted aquatic plants. This is somewhat dependent on the ability of light to penetrate the water. Specific animal groups also inhabit this zone.

Loading: The total amount of material (sediment or nutrients) entering a water body via streams, overland flow, precipitation, direct discharge, or other means over time (usually considered annually). Recycling of nutrients among sediment, organisms and water is sometimes referred to as "internal loading."

Mean: (see "Average') The sum of a group of numbers divided by the total number of values in the group.

Median: The datum in a set of numbers that represents the exact center of the group: half of the numbers are smaller and the other half are larger.

Metalimnion: The layer of water in a lake between the epilimnion and hypolimnion in which the temperature, and thus density, change rapidly over a short distance.

Monomictic: A water pattern of lakes in which thermal mixing and stable stratification alternate once per year.

Nitrogen: One of the elements essential for the growth of organisms. Nitrogen is most abundant on the earth in the form of N_2, comprising 80% of the atmosphere, but is usually taken up by plants in the forms NO_3, NO_2 and NH_3.

Nonpoint Source Pollution: Pollution from a diverse set of sources difficult to pinpoint as separate entities and thus to control or manage. Examples of "nonpoint sources" include area-wide erosion (as opposed to landslides or mass wasting), failure of

septic systems, some farming practices or forestry practices, and residential/urban land uses (such as fertilizing or landscaping).

Noxious weeds: A legal definition of the State of Washington that lists specific non-native, invasive plants known to destroy habitat for other plants or animals, or documented as having caused serious agricultural problems. A list of names is published each year by the Department of Ecology which lists the level of threat posed by the plants and the legal responsibilities of owners who find them growing on their properties. Individual counties may modify the list to fit specific distributions within the county.

Nutrient: Any chemical element, ion, or compound required by an organism for growth and reproduction.

Oligotrophic: Waters that are nutrient poor and which, as a result, have little algal production.

pH: The negative logarithm of the hydrogen ion concentration in a solution. This is a measure of acidity.

Pheophytin: A pigment resulting from the degradation of chlorophyll *a*, usually found in algal remains, suspended organic matter, or bottom sediments.

Phosphorus: One of the elements essential for growth and reproduction. Phosphorus is often the limiting, or least available, nutrient for plant growth in temperate freshwater ecosystems. The primary original source of phosphorus is from the earth in the form of phosphate rocks.

Photic Zone: The volume of water in a lake bounded by the depth to which light penetrates enough to enable plants to carry out photosynthesis.

Photosynthesis: The production of organic matter (carbohydrates) from inorganic carbon and water, utilizing the energy of light.

Phytoplankton: Free floating microscopic organisms that photosynthesize (algae and cyanobacteria).

Productivity: The production and accumulation of organic matter, usually measured over a certain period of time.

Residence Time: The average length of time that water or a chemical within the water, such as phosphate, remains in a lake.

Secchi Disk: A 20-cm (8-inch) diameter disk painted white and black in alternating quadrants. It is used to measure the transparency of the water in lakes.

Sediment: Solid material deposited in the bottom of a lake over time.

Stratification: The separation of water into nearly discrete layers caused by differences in temperature and subsequent water density differences.

Thermocline: The zone of rapid temperature decrease in a vertical section of lake water. (See metalimnion.)

Transparency: Water clarity of a lake as measured with a Secchi disk.

Trophic State: A term used to describe the productivity of a lake ecosystem classifying it as one of three increasing categories based on algal biomass: oligotrophic, mesotrophic, or eutrophic.

Turbidity: Cloudiness in water caused by the suspension of tiny particles (algae or detritus).

Turnover: The mixing of lake water from top to bottom after a period of stable stratification. This typically occurs in fall and is caused by wind and seasonal cooling of surface waters.

Van Dorn Vertical Sampler: A water sampling device that allows collection of a water sample from a desired depth without contaminating the sample with water from other depths.

Watershed: The geographical area that contributes surface and groundwater flow to a stream, lake, or other body of water. This can also be referred to as the "catchment basin" or "drainage basin."

Watershed Management: The planning and carrying out of actions, legal requirements and protective measures taken by agencies and citizens to preserve and enhance the natural resources of a drainage basin for the production and protection of water supplies and water-based resources.

Water Year: A division of the earth year based on generally perceived wet and dry periods rather than by calendar months. The U.S. Geological Survey uses the water year of October 1 through September 30 for data analysis.

Zooplankton: Small animals found in the water of lakes that possess limited powers of locomotion, and which feed on bacteria, algae, smaller animals, and organic detritus present in the water.

Appendix E

Resources

Temperature Conversions

Fahrenheit to Centigrade: (°F - 32) / 1.8
Centigrade to Fahrenheit: (°C x 1.8) + 32

Lake Organizations

North American Lake Management Society (NALMS)
PO Box 5443 / 4513 Vernon Blvd., Suite 100, Madison, WI 53705-0443
Phone: 608-233-2836 / Fax: 608-233-3186
www.nalms.org

Washington State Lake Protection Association (WALPA)
P.O. Box 1206 Seattle, WA 98111-1206
800-607-5498 x116
www.nalms.org/walpa/

Western Aquatic Plant Management Society (WAPMS)
www.wapms.org

Online Resources

King County Code
(See Title 21 for zoning information. Does not cover codes for individual cities.)
www.metrokc.gov/mkcc/code/index.htm

King County Department of Development and Environmental Services
www.metrokc.gov/ddes/

King County Department of Natural Resources and Parks
Environmental Laboratory
http://dnr.metrokc.gov/wlr/envlab/labguide/labguide.htm

Lake Stewardship Program
http://dnr.metrokc.gov/wlr/waterres/smlakes/

Lake Topics
http://dnr.metrokc.gov/topics/lakes/

Noxious Weed Control Program
http://dnr.metrokc.gov/wlr/lands/weeds/prog_info.htm

Yard and Garden Topics
http://dnr.metrokc.gov/topics/yard-and-garden/

North American Lake Management Society
www.nalms.org

Save Lake Sammamish
www.scn.org/earth/savelake/

United States Environmental Protection Agency: Clean Lakes
www.epa.gov/owow/lakes

Washington State Department of Ecology
www.ecy.wa.gov

Washington State Lake Protection Association
www.nalms.org/walpa/

Video

Lakeside Living
This 23-minute video focuses on shoreline management and lakeside landscaping practices to improve water quality, shoreline stability, and wildlife habitat. Ideal for lake community groups, home owners and associations and general lake education. The video is available for loan through any King County Library or for purchase by calling 206-296-6519.

Brochures

The King County Department of Natural Resources, Water and Land Resources Division has a variety of informational brochures to choose from. To request a copy of any of the following titles, call 206-296-6519. A complete list of all King County Department of Natural Resources and Parks publications can be found online at: http://dnr.metrokc.gov/topics/publications/publtopic.htm.

General Lake Management

- *A Citizen's Guide to Understanding and Monitoring Lakes & Streams*
- *Get Your Feet Wet: Volunteer opportunities to keep water and land healthy for people and wildlife*
- *The Lake Steward Newsletter*
- *Small Lake Recreation At-A-Glance*
- *Toxic Algae*
- *The Washington Lake Book: A handbook for lake users*

Weeds

- *Aquatic Plants: Identification, benefits, and management*
- *Aquatic Plants and Fish*
- *How to Control Aquatic Weeds*
- *Selected Noxious Weeds*

Landscaping

- *Going Native: a guide to creating your own native plant landscape*
- *Grow smart, grow safe: A consumer guide to lawn and garden products*
- *Make your lawn, happy, healthy, and naturally the envy of the neighborhood*
- *Natural Lawn Care: for western Washington*
- *Natural Yard Care: Five steps to make your piece of the planet a healthier place to live*
- *Trouble free plants for the Pacific Northwest*

Other

- *Can We Afford to Loose Our Forests?*
- *Funding Sources: The Grant Exchange*
- *King County Agriculture*
- *Watershed Resource Program*

Books

Lake Ecology and Management

A Citizen's Guide to Understanding and Monitoring Lakes and Streams
By Joy P. Michaud; Washington State Dept. of Ecology, 1991
Available online at: http://www.ecy.wa.gov/biblio/94149.html
The intent of this guide is to introduce citizens in the Puget Sound area to lake and stream water quality monitoring. It provides background information on monitoring in the Puget Sound region and then describes some of the advantages and pitfalls of citizen monitoring. It contains an introduction to lake and stream ecology then describes different water quality measurements and their important.

How to Know the Freshwater Algae
By G. Prescott et al.; McGraw-Hill, 1978
This is a fantastic book for those interested in identifying algae to a Genus level. The book offers very good descriptions and lots of helpful illustrations.

Lake and Pond Management Guidebook
By Steve McComas; Lewis Publishers, 2003
This guidebook contains over 300 ideas and projects including step-by-step practical, low-cost solutions to a wide range of problems that lake management professionals face everyday. Coverage includes shoreland buffer installation, fisheries management, reducing nuisance algal growth, controlling exotic aquatic plants, lakeside wastewater treatment systems, small scale dredging, and more.

Limnology
By Charles R. Goldman and Alexander J. Horne
McGraw Hill, 2nd edition, 1994
Intended for biology and environmental sciences students, this study of lake systems covers the physics, chemistry and biology of lakes. The text includes ecosystem examples to illustrate basic concepts in limnology.

Limnology
By Robert G. Wetzel; Academic Press, 3rd edition, 2001
A new edition of this established classic text. The coverage remains rigorous and uncompromising and has been thoroughly reviewed and updated with evolving recent research results and theoretical understanding. In addition, the author has expanded coverage of lakes to reservoir and river ecosystems in comparative functional analyses. Very technical.

Pond Life A Golden Guide
Western Publishing Company, 1987
In print for two decades, this is still one of the best introductory guides to common pond plants and animals. Includes chapters on physical and chemical characteristics of water, habitats, food webs, community changes, observation and collection, and descriptions of common pond animals from protozoa to mammals.

Plants: Field Guides

An Aquatic Plant Identification Manual for Washington Freshwater Plants
By Kathy Hamel, Jenifer Parsons et al.;
Washington State Department of Ecology, 2001
The purpose of this manual is to help with identifying aquatic plants that are likely to be seen in Washington's freshwater lakes and rivers. This manual has been written for people who do not have a scientific background, but it also should be useful for professionals who need assistance in identifying aquatic species.

Aquatic and Riparian Weeds of the West
By Joseph M. DiTomaso and Evelyn A. Healy;
University of California, 2003
A guide to identifying riparian and aquatic weeds found in the Western United States. Includes submerged, floating leaf, and emergent aquatic weeds. In addition to the individual description of species and related species, the text also contains identification tables for groups that share similar, unusual or relatively uncommon characteristics.

Field Guide to the Common Wetland Plants of Western Washington and Northwestern Oregon
Sarah Spear Cooke, Editor; Seattle Audubon Society, 1997
An exceptional collection of botanical information, this book provides helpful descriptions and locations of plants from the lowland wetland habitats, including both freshwater and coastal, and is highlighted by spectacular color photographic images useful for easy identification. The guide covers more than 300 species of wetland plants including trees, shrubs, herbs, grasses and ferns.

Northwest Weeds: The Ugly and Beautiful Villains of Fields, Gardens and Roadsides
By Ronald J.Taylor; Mountain Press Publishing Company, 1990
Field Guide to the prominent weeds of the Pacific Northwest, the northern Rockies, and Southwestern Canada.

Plants of the Pacific Northwest Coast
By Jim Pojar and Andy MacKinnon; Lone Pine Publishing, 1994
This easy-to-use field guide features 794 species of plants commonly found along the Pacific coast from Oregon to Alaska, including trees, shrubs, wildflowers, aquatic plants, grasses, ferns, mosses and lichens. The book includes clear species descriptions and descriptions of each plant's habitat and range. Engaging notes on each species describe aboriginal and other local uses of plants for food, medicine and implements, along with unique characteristics of the plants and the origins of their names. For both amateurs

and professionals, this is the best, most accessible, most up-to-date guide of its kind.

Wetland Plants of Oregon and Washington
By B. Jennifer Guard; Lone Pine Publishing, 1997
This concise and easy-to-use field guide provides a wealth of information about the plants of the rich wetland ecosystems of Oregon and Washington. Grouped by habitat, it describes wooded wetland, wetland prairie, marshy shore, shrub swamp and the submerged and floating communities.

Gardening

Gardening with Native Plants of the Pacific Northwest: An Illustrated Guide
By Arthur R. Kruckeberg
University of Washington Press, 1982
A fabulous resource from one of the region's foremost authorities. Good notes on propagation.

Grow Your Own Native Landscape: A guide to identifying, propagating, and landscaping with Western Washington native plants
Washington State University Cooperative Extension, Thurston Co.
Available from: WSU Cooperative Extension, Thurston County, Native Plant Salvage Project, 6128 Capitol Blvd. SE, Ste. 3, Olympia, WA 98501, 360-786-5445
This clearly organized guide contains plant information including habitat, advantages or disadvantages of using each plant, and methods of propagation. Other sections of the book contain information about how to decide what native plants would be best for your yard, detailed instructions for propagating and salvaging native plants, and an important section on problem aquatic and terrestrial plants.

Landscaping for Wildlife in the Pacific Northwest
By Russell Link
The Washington Department of Fish and Wildlife and University of Washington Press, 1999
Whether you are planting a yard from scratch or modifying an existing area this book will help you select, arrange, and maintain plants and other landscape elements that fulfill wildlife needs.

Native Plants in the Coastal Garden: A Guide for Gardeners in the Pacific Northwest
By April Pettinger; Timber Press 2003
An all-encompassing guide, this book is ideal for gardeners from the Pacific Ocean to the Coast Mountains in British Columbia. The six chapters make sure all the bases are covered in identifying plant habitats, attracting wildlife and locating regional plants and seeds specifically adapted to the growing conditions of a coastal garden.

The Wild Lawn Handbook: Alternatives to the Traditional Front Lawn
By Stevie Daniels; Macmillan, 1995
The Wild Lawn Handbook is the definitive guide to transforming the traditional grass lawn into a beautiful alternative lawn using native grasses, ferns, mosses, wildflowers, low-growing shrubs, and perennials. In the last few years, there has been a mass effort to raise public awareness of the toxicity and water-wasting nature of the American lawn, making wild lawns a hot gardening topic. This is the first comprehensive book to show you step-by-step.

Animals: Birds

The Birder's Handbook
By Paul R. Ehrlich et al.; Simon and Schuster 1988
A field guide to the natural history of North American birds: nesting, breeding, diet, etc., the essential companion to any identification guide. A complete and authoritative reference book, up to date and in field guide format.

Birding in Seattle and King County: Site Guide & Annotated Lists
By Eugene S. Hunn, 2003
This book is a must for both professional wildlife biologists and curious birding novices around King County. Included is information on 27 different bird species, and their habitats, in the Seattle/King County area.

Field Guide to the Birds of North America, 4th Edition
National Geographic Society, revised 2002
This standard guide focuses on accuracy and ease of use in the field and features all species known to breed in North America – more than 800 in all. This edition is illustrated with specially commissioned full-color illustrations, has newly updated range maps, and detailed descriptions. The index makes it simple for birders in the field to quickly identify a species. An excellent, all-around field guide.

The Sibley Field Guide to Birds of Western North America
By David Allen Sibley; Alfred A. Knopf, 2003
This new field guide has all the information, detail, and beauty of the Sibley Guide to Birds, but for western North America (650 species), in a portable format. Geared to the novice birder, each species account includes information about status, habitat, feeding, behavior, identification, song and all new maps.

The Sibley Guide to Bird Life and Behavior
By David Allen Sibley, Illustrator; Alfred A. Knopf, 2001
The Sibley Guide to Bird Life and Behavior is a complete guide to the bird families found in North America. It features 796 full-color paintings by David Sibley and is written by 44 of America's top birders and ornithologists. Includes information about bird biology, life cycles, courtship, nest-building, migration, and feeding.

The Sibley Guide to Birds
By David Allen Sibley; Alfred A.Knopf, 2000
Sibley depicts and describes 810 species and 350 regional populations, detailing their stages, shapes, forms, colors, and field marks. He describes each species' calls and provides full-color range maps. A tremendous variety of plumages are shown, plus color flight pictures and flight silhouettes, behavior sketches, and frontal and side views of perched birds.

Animals: Mammals, Reptiles, Amphibians and Fish

Amphibians of Washington and Oregon
By William P. Leonard et al.; Seattle Audubon Society, 1996
This addition to the Trailside Series provides detailed accounts of 33 species of amphibians common to Washington and Oregon. The exciting color photography illuminates the beauty of these creatures rarely seen by the casual observer. This field guide is a must for all nature lovers.

Inland Fishes of Washington, Second Edition
By Richard S. Wydoski and Richard R. Whitney
American Fisheries Society in association with University of Washington Press, 2003
This updated (first published in 1979) and greatly expanded edition describes all known native and introduced fishes found in freshwater habitats of Washington State. The book provides instruction on the basic methods of fish identification, with keys and illustrations that bring together the traits and forms most useful in distinguishing species and subspecies. The keys follow a simple arrangement that progressively illustrates and discusses traits distinctive to each fish.

Mammals of the Northwest
By Earl J. Larrison; Seattle Audubon Society, 1976
Part of the Seattle Audubon Society Trailside Series, this guides the amateur mammal watcher to 200 different species and their

habitats. This book provides valuable information with detailed descriptions of each animal and the locations in which they can be found, ranging from antelopes to wood rats.

Mammals of the Pacific Northwest: From the Coast to the High Cascades
By Chris Maser; Oregon State University Press, 1998
This remarkable book offers an intimate look at the life histories and habitats of mammals in the Pacific Northwest. In introducing the region's mammals, Chris Maser combines current scientific knowledge with personal accounts and anecdotes drawn from over a quarter century of fieldwork in Oregon. For each species of mammal, the book provides a physical description and detailed information on distribution, habitat, and behavior, and it is illustrated with over 100 photographs of mammals and their tracks, dens, nests, and young.

Reptiles of Washington and Oregon
By Herbert A. Brown et al.; Seattle Audubon Society, 1995
An easy-to-use field guide, this book makes a wonderful addition to any reference collection. The compilation brings to life thirty-five species of reptiles native to Washington and Oregon. An excellent tool for identification, the Seattle Audubon Society has captured these animals in illustrative and exceptional color photography.

Animals: Insects

Bugs of Washington and Oregon
By John Acorn; Lone Pine Publishing, 2001
A field guide to the ''coolest'' 125 of the 25,000 species of bugs found in Oregon and Washington. Large, clear, detailed color illustrations and informative and often humorous text. Ideal for any budding entymologist.

The Butterflies of Cascadia: A Field Guide to All the Species of Washington, Oregon, and Surrounding Territories
By Robert Michael Pyle; Seattle Audubon Society, 2002
This definitive work on the butterflies of the Northwest is a comprehensive guide to the entire Pacific Northwest region. Filling 420 pages and containing more than 600 color photographs as well as superb paintings and spread specimens for almost every species, this book identifies and illuminates Northwest fauna.

Dragonflies of Washington
By Dennis Paulson; Seattle Audubon Society, 1999
Covers all of the 20 damselflies and 56 dragonflies recorded in Washington State, with many color photos.

A Guide to Common Freshwater Invertebrates of North America
By J. Reese Voshell; McDonald & Woodward Publishing Company, 2001
A comprehensive guide for teachers, naturalists, environmentalists, anglers and others interested in identifying and understanding this very diverse group of animals. Includes detailed sections on the biology, ecology, taxonomy and life histories of hundreds of freshwater invertebrates, all written using accurate yet non-technical language. Beautiful color plates and detailed sketches.